SCIENTIFIC OBJECTIVES FOR A FUTURE TITAN MISSION

ATHENA COUSTENIS(1)*, JONATHAN LUNINE(2), RALPH LORENZ(3), DENNIS MATSON(4), KIM REH(4), JEAN-PIERRE LEBRETON(5), CHRISTIAN ERD(5), PATRICIA BEAUCHAMP(4), THE TSSM SDT

(1) LESIA, Observatoire de Paris-Meudon, France (2) Dipartimento di Fisica, Università degli Studi di Roma "Tor Vergata", Rome, Italy, (3) APL, The Johns Hopkins Univ., USA, (4) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, (5) ESA/ESTEC, Noordwijk, The Netherlands

e-mail: *athena.coustenis@obspm.fr*

ABSTRACT

Titan is a complex world more like the Earth than any other: it has a dense mostly nitrogen atmosphere and active climate and meteorological cycles where the working fluid, methane, behaves under Titan conditions the way that water does on Earth. Its geology, from lakes and seas to broad river valleys and mountains, while carved in ice is, in its balance of processes, again most like Earth. Beneath this panoply of Earth-like processes an ice crust floats atop what appears to be a liquid water ocean. Titan is also rich in organic molecules—more so in its surface and atmosphere than anyplace in the solar system, including Earth. These molecules were formed in the atmosphere, deposited on the surface and, in coming into contact with liquid water may undergo an aqueous chemistry that could replicate aspects of life's origins.

An extensive mission to Titan, the Titan Saturn System Mission (TSSM), studied last year [1] and prioritized second for a launch around 2023-2025 by the space agencies, consists of an Orbiter that would carry two in situ elements: the Titan montgolfière hot-air balloon and the Titan Lake Lander. The mission would arrive at Saturn around 2032-2034 for a ~4-year mission. Soon after arrival at Saturn, the montgolfière would be delivered and deployed in Titan's atmosphere for a mission of airborne, scientific observations of Titan from an altitude of about 10 km. The montgolfière would have a Multi-Mission Radioisotope Thermoelectric Generator (MMRTG) power system designed for a 6-12 month mission in Titan's atmosphere. With the predicted winds and weather, that would be sufficient to circumnavigate the globe at least once.

Besides other measurements, valuable information on the troposphere of Titan would be gathered by the balloon. The Lake Lander would descend through the atmosphere, making measurements of the atmospheric properties, much like Huygens did, and then land and float on one of Titan's seas. After delivery of the in situ elements, the TSSM Orbiter would explore the Saturn system via a ~2-year tour that includes in situ sampling of Enceladus' plumes as well as Titan flybys. After the Saturn system tour, the TSSM Orbiter would enter orbit around Titan and begin a global survey phase. Synergistic and coordinated observations would be carried out between the TSSM Orbiter and the in situ elements.

This paper focus on the scientific objectives of the in situ elements [1,2] of such a future mission to Titan as determined by the Science Definition Team.

References

[1] TSSM NASA/ESA Joint Summary Report, 16 January 2009

[2] Coustenis et al. (2008). Experimental Astronomy, **23**, 893-946, DOI: 10.1007/s10686-008-9103-z.